IDS' was filed prior to the issuance of a first office action on the merits, no fee is due for consideration of the listed items.

Also enclosed is a Supplemental Information Disclosure Statement and Form 1449/PTO listing references cited in the divisional application, with a check for the required fee.

Consideration of the listed references is requested.

Rejections under 35 U.S.C. § 102 (DeBoer)

The Examiner rejected Claims 1-4, 9-10, [12]-17, 20-23, 30-31, 36-39, 41-42, 47-52, 60-62, 64, 72-74, 76, 78, 80, 125-126, 128, 130, 132 and 134 under Section 102 as anticipated by USP 6,326,277 (DeBoer). This rejection is respectfully traversed.

The Examiner cites DeBoer as disclosing all of the elements of the claims.

DeBoer is directed to solving a different problem than Applicant's invention. DeBoer is directed to solving the problem of grains of HSG silicon breaking off along the edge of an HSG silicon layer during processing. (See at col. 1, line 51 to col. 2, line 5.)

> Although CMP is effective at separating the containers, it leaves a structure in which the hemispherical grain silicon precursor layer (i.e., the layer from which the hemispherical grain silicon is formed) and the underlying doped silicon layer both extend to the upper edge of the capacitor plates. As a result, after conversion of the hemispherical grain silicon precursor layer to a layer of hemispherical grain silicon by, e.g., seeding and annealing or any other suitable technique, the hemispherical grain silicon layer typically extends above the outer layer of doped silicon along the edges of the capacitor plates.
>
> Grains or particles from the edge of the hemispherical grain silicon layer are, however, susceptible to separation from the hemispherical grain silicon layer. Once separated or broken off, the loose particles can fall between adjacent capacitors because they extend above the outer layers of the containers, resulting in electrical shorts between the adjacent capacitors. Such defects adversely affect the output of the manufacturing processes used to form the capacitors...

To that end, DeBoer discloses a method to eliminate HSG silicon growth along the edge of a layer. DeBoer achieves this by selectively doping an edge portion of an HSG silicon precursor layer — to prevent conversion of the HSG silicon precursor to HSG silicon along the edge of the layer. See at col. 7, lines 39-57.

This process is illustrated in FIGS. 6-7 (below). As shown in FIG. 6, a portion 28 of the HSG silicon precursor layer 34 is selectively doped. HSG silicon is then formed on the undoped portion of layer 34 — but not the doped edge portion 28. See at cols. 8-9, bridging paragraph:

> The undoped portions of the second layer 34 below the edge zone 28 can be converted to hemispherical grain silicon via any suitable technique. The resulting structure is illustrated in FIG. 7. The edge zone 28 of doped silicon from the second layer 34 that was created about the upper portions of the sidewall structure 24 of the cavity 20 does not convert to hemispherical grain silicon as does the undoped silicon. Because the hemispherical grain silicon is recessed within the cavity 20, subsequent processing steps are unlikely to dislodge grains of HSG silicon that could fall outside of the cavity 20 and short adjacent capacitor structures or cause other defects.

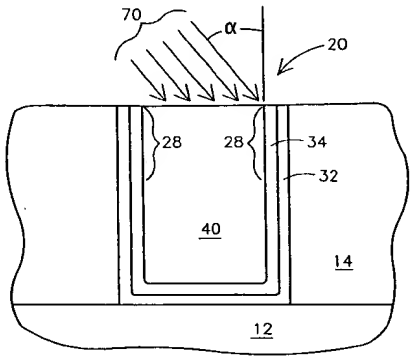

FIG. 6

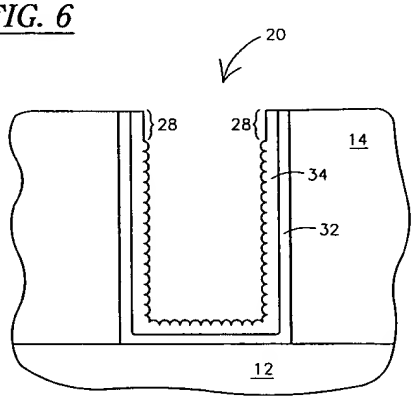

FIG. 7

DeBoer discloses that a dielectric layer 50 can then be provided within the cavity, as disclosed at col. 9, lines 35-36, and illustrated in FIG. 8.

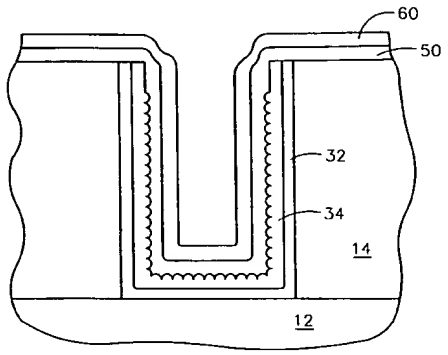

FIG. 8

DeBoer provides no information for forming a *uniform* dielectric layer over both a nitride *resistive* material (e.g., BPSG, oxides, etc.) and a nitride *receptive* material (e.g., HSG silicon, etc.), as claimed by Applicant.

Applicant is directed toward solving the problem of uneven thickness of a nitride insulative layer when deposited over different types of material layers — i.e., a nitride *resistive* material and a nitride *receptive* material. Applicant achieves this by implanting an agent into exposed surfaces of the nitride *resistive* material layer — e.g., BPSG, oxides, etc.

The implanted surface-modifying agent within the nitride resistive material layer functions to modify the surface of the layer so that a subsequently formed nitride dielectric layer has a uniform thickness over both the nitride resistive material and a nitride receptive material. (See, e.g., Claims 1 and 125.)

By comparison, DeBoer discloses that the precursor layer 34 is implanted with a species that functions to prevent conversion of the HSG silicon precursor to HSG silicon (col. 7, lines 39-49):

> After removal of the first layer 32, second layer 34...That structure can then be subjected to an ion implantation process in which an upper portion, referred to herein as an edge zone 28, of the second layer 34 is implanted with an N-type dopant, P-type dopant, *or other species such as oxygen or nitrogen that can prevent conversion of the hemispherical grain silicon precursor in the second layer 34 to hemispherical grain silicon.*

DeBoer's doping of an HSG silicon precursor layer —*to inhibit HSG silicon growth* — does not teach or suggest Applicant's method involving implanting a surface-modifying agent into a nitride resistive material layer —*to enhance formation of a dielectric layer* having a uniform thickness over the nitride resistive layer and a nitride receptive layer. Accordingly, withdrawal of this rejection is respectfully requested.

Rejections under 35 U.S.C. §103(a) (DeBoer as primary reference)

The Examiner rejected Claims 11, 40 and 65 under Section 103(a) as obvious over DeBoer; Claims 5 and 43 as obvious over DeBoer in view of USP 5,783,469 (Gardner); and Claims 55-58, 63, 75, 81-83, 85, 87-88, 90, 131 and 135-136 as obvious over DeBoer in view of USP 5,118,636 (Hosaka). These rejections are respectfully traversed.

With respect to Claims 11, 40 and 65, the Examiner cites DeBoer as disclosing all of the elements of the claims except for the implantation dosage. However, the Examiner maintains that the selection of the implantation dosage would be obvious as a matter of determining an optimum process condition.

First of all, as stated above, DeBoer discloses implanting an HSG precursor layer 34 with a species that *functions to prevent conversion of the HSG silicon precursor to HSG silicon.* In addition, DeBoer discloses that the dopant is implanted *at a concentration level that reduces/prevents such conversion of the HSG silicon precursor.* See at col. 7, lines 39-49 (emphasis added):

> After removal of the first layer 32, second layer 34...That structure can then be subjected to an ion implantation process in which an upper portion, referred to herein as an edge zone 28, of the second layer 34 is implanted with an N-type dopant, P-type dopant, *or other species such as oxygen or nitrogen that can prevent conversion of the hemispherical grain silicon precursor in the second layer 34 to hemispherical grain silicon.*
>
> *The dopant is implanted at a concentration level that substantially reduces, more preferably substantially prevents, formation of hemispherical grain silicon from the second layer 34 in the edge zone 28...*

DeBoer does not provide information on the concentration amount of an agent for implantation in a nitride resistive material layer to provide for the formation of a dielectric layer having a uniform thickness over the nitride resistive layer and a nitride receptive layer.

For that reason and the reasons stated above with respect to the disclosure of DeBoer, withdrawal of this rejection is respectfully requested.

Next, with respect to Claims 5 and 43, the Examiner cites DeBoer as disclosing all of the elements of the claims except for the surface-modifying agent being trifluoronitride (NF_3). However, the Examiner cites to Gardner as teaching that nitrogen and trifluoronitride are art recognized equivalents as implant gases.

Gardner is directed to fabricating an integrated circuit in which nitrogen is introduced into a conductive gate layer (e.g., heavily doped polysilicon) and an underlying gate dielectric layer. The nitrogen purportedly functions to form stronger bonds between a silicon gate layer and the underlying dielectric layer for improved transistor characteristics, and to inhibit the diffusion of impurities (i.e., boron) from the gate into the underlying active region.

As DeBoer is inapplicable for the above-stated reasons, combining Gardner's disclosure of the use of NF_3 as an implant gas does not make obvious Claims 5 and 43. DeBoer, either alone or combined with Gardner, does not obviate Applicant's method comprising implanting a surface-modifying agent into a nitride resistive material layer for forming a dielectric layer having a uniform thickness over the nitride resistive layer and a nitride receptive layer. Accordingly, withdrawal of the rejection of these claims is respectfully requested.

With respect to Claims 55-58, 63, 75, 81-83, 85, 87-88, 90, 131 and 135-136, the Examiner cites DeBoer as disclosing all of the elements of the claims except for rotating the substrate during the implantation step. However, the Examiner cites to Hosaka as disclosing a method of rotating a substrate during implantation. The Examiner maintains that it would be obvious to modify DeBoer's method to rotate the substrate during implantation in order to prevent a shadowing effect.

Hosaka is directed toward forming a trench in a semiconductor substrate such that the walls along the entire depth of the trench are uniformly doped. Hosaka achieves this by first doping a thickness of the substrate with impurity ions — P, As, Sb, B, etc., depositing an insulation film layer over the substrate, and then a photoresist layer, and etching the trench in the doped substrate using the insulation film and the photoresist layer as a mask.

First of all, there is no motivation to combine the teachings of Hosaka with DeBoer.

Hosaka is directed toward uniformly doping the walls along *the entire depth* of a trench disposed within a semiconductive material layer. Hosaka addresses problems with the shadowing effect (i.e., a portion of the trench not being implanted with ions) caused by blocking of ions by a masking resist during ion implantation when the incident angle of ions is adjusted at 7° (to prevent a channeling phenomenon) (col. 1, lines 27-35).

To that end, Hosaka teaches steps to *avoid* the shadowing effect by reducing the thickness of the mask layer and inserting a material to stop ions, or to carry out a zero degree (0°) ion implantation — a vertical ion implantation relative to the surface of the semiconductor substrate (see at col. 3, lines 43-52; emphasis added):

> The mask to be used for the present invention becomes thicker as the depth of the ion implanted layer or the depth of the trench becomes deeper, *accordingly the shadowing effect is also a problem during ion implantation.* The solution to this problem is to reduce the thickness of the mask layer by inserting a material having a large capacity to stop ions, or to carry out the "zero degree ion implantation", the ion implantation carried out as vertically as possible in relative to the surface of a semiconductor substrate...

By comparison, DeBoer is directed to *selective doping* of an HSG silicon precursor layer *limited to an edge zone of an opening.* To that end, DeBoer teaches the *desirability* of a shadowing effect during implantation to limit the implant to the upper edge zone of the opening.

> In addition to, or in place of, reliance on energy levels to control implant depth, it may be desirable to rely on an implantation angle α that is greater than zero. By directing the dopant ions 70 at an implantation angle α that is greater than zero, preferably about 5 degrees or more, and more preferably about 45 degrees or more, the ***lower portions of the second layer 34 within the cavity 20 will be protected from dopant implantation by shadowing of the opposite side of the cavity 20.*** Those undoped portions of the hemispherical grain silicon precursor in the second layer 34 below the edge zone 28 remain convertible to hemispherical grain silicon, while the doped portions in the edge zone 28 do not convert to hemispherical grain silicon.

Furthermore, Hosaka essentially teaches away from rotating a substrate during doping.

Hosaka, in the Background section, mentions the use of a rotating ion implantation method to avoid the shadowing effect — but states the undesirability of such a method due to difficulties with control and the need for complex apparatus (at col. 1, lines 36-39):

> The rotating ion implantation method is used in order to prevent the shadowing effect. However this method requires a complex apparatus, and the control of the apparatus is extremely difficult....

With respect to Claim 57, the Examiner further maintains that DeBoer with Hosaka discloses all of the elements of the claim except for the implantation dosage. However, the Examiner maintains that the selection of the implantation dosage would be obvious as a matter of determining an optimum process condition.

For the reasons stated above with respect to Claims 11, 40 and 65, DeBoer does not provide information on the concentration amount of an agent for implanting in a nitride resistive material layer to provide for the formation of a dielectric layer having a uniform thickness over the nitride resistive layer and a nitride receptive layer. As previously stated, DeBoer discloses implanting an HSG precursor layer with a species that *functions to prevent conversion of the HSG silicon precursor to HSG silicon — at a concentration level that reduces/prevents such conversion of the HSG silicon precursor.*

There is no motivation to combine the disclosure of Hosaka with that of DeBoer. Moreover, arguably, even if one were to combine the teaching of Hosaka with DeBoer as suggested by the Examiner, it does not overcome the deficiencies of the primary reference for the previously stated reasons. Neither of these references, either alone or in combination, teach or suggest Applicant's method as claimed. Accordingly, withdrawal of this rejection is respectfully requested.

Election/Restrictions - Generic Claim. Contrary to the Examiner's statement at page 2, Applicant submits that Claim 125 is generic (or linking) to all of Claims 1-91 and 126-136.

Claim 125 recites a method of forming a nitride dielectric layer over a nitride resistive material and a nitride receptive material, comprising the steps of:

> implanting a surface-modifying agent into exposed surfaces of the nitride resistive material; and
>
> forming the nitride dielectric layer over the nitride resistive material and the nitride receptive material, wherein the nitride dielectric layer has a substantially uniform thickness over the nitride resistive material and the nitride receptive material.

An examination of each of Claims 1-91 and 126-136 will confirm that each claim includes all the limitations of Claim 125.

Applicant notes that the previous election of species is for the purpose of prosecution on the merits, and that Applicant will be entitled to consideration of claims to additional species upon allowance of a generic claim. MPEP § 806.04(d). It is understood that if the claims of the

elected species are found allowable over the prior art, the Examiner will expand the search to include other species.

Extension of Term. The proceedings herein are for a patent application and the provisions of 37 CFR § 1.136 apply. Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that Applicant has inadvertently overlooked the need for a petition for extension of time.

Based on the above remarks, the Examiner is respectfully requested to reconsider and withdraw the rejections of the claims. It is submitted that the present claims are in condition for allowance, and notification to that effect is respectfully requested.

Respectfully submitted,

Kristine M. Strodthoff

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Kristine M. Strodthoff
Reg. No. 34,259

WHYTE HIRSCHBOECK DUDEK S.C.
111 East Wisconsin Avenue, Suite 2100
Milwaukee, Wisconsin 53202
(414) 273-2100
Customer No. 31870